Identifying contagion in a banking network

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17th FDIC-JFSR Fall Bank Research Conference
September 2017

What we do and find

- Look for evidence of transmission of shocks through a network of bank CDS counterparty relationships.
- **Null hypothesis (no transmission):** Bank buying protection suffers no additional loss by virtue of counterparty losses, controlling for its own losses.
- **Alternative (transmission):** Bank's exposure to corporate default increases whenever counterparties from which it has purchased default protection experience losses.
- **Main result:** Evidence in favor of the alternative – bank's own CDS spread increases when counterparties from whom it bought protection suffer losses.

Related literature and our contribution

- Our work extends the literature on systemic risk and contagion.
- Many theoretical studies on systemic risk in banking systems:
  - Exposure to common shocks: Wagner (2010), Acharya (2009), Acharya and Yorulmazer (2007), Farhi and Tirole (2012);
  - Structural funding risks: Allen and Gale (2000), Freixas, Parigi and Rochet (2000), Allen, Babus and Carletti (2012), Heider, Hoerova and Holthausen (2015);
  - Network topology: Gai, Haldane and Kapadia (2011), Blume, Easley, Kleinberg, Kleinberg and Tardos (2011), Acemoglu, Ozdaglar and Tahbaz-Salehi (2015).
- But little evidence on contagion so far: Iyer and Peydro (2011).
- Our contribution is to provide evidence of contagion, rather than interdependence, in a well-defined interbank network of CDS exposures.

Empirical implementation

Ideal:

- Data on all bank economic exposures, including to all other bank and financial entities.
- Look at exogenous shocks to own, counterparty and non-counterparty position values, and how bank CDS spreads and equity returns affected.

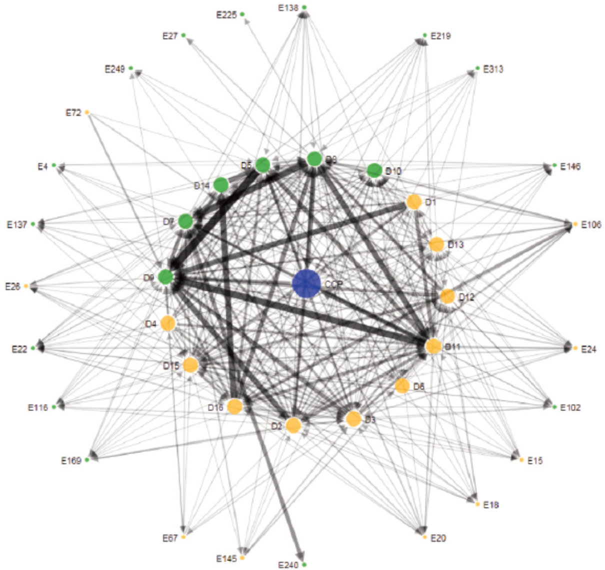
Actual:

- Only have data on CDS positions on all UK reference entities (names), CDS quoted spreads and equity returns (potential omitted variables problem).
- ISDA master agreements call for collateral and netting (biases against finding anything).

Data

- Daily CDS transactions on all UK reference entities from DTCC, 2009-2014, obtained by the Bank of England via the Financial Conduct Authority (FCA).
- This dataset includes all transactions in UK reference entities, not just those to which a UK-regulated firm is a party $\rightarrow$ we can see the full network of exposures generated in this market.
- Daily CDS spreads from Markit, all other data (equity returns, VIX etc.) standard.
- From the transactions data and CDS spreads, we are able to reconstruct daily time-series of bilateral positions and changes in mark-to-market value of banks' UK CDS trading books.

UK CDS market - Network of exposures



Gross notional: EUR 540-640 billion, Net notional: EUR 24-26 billion

Baseline regression specification

We run variations of the following panel regression:

$$R_{i,t} = \beta \Pi_{i,t} + \gamma K_{i,t} + \delta \sum_{j \neq i} \Pi_{j,t} + \zeta \sum_{j \neq i} NP^{\text{Bank}}_{i,j,t} + controls + \epsilon_{i,t}$$

where

$R_{i,t}$	Bank i's CDS return
$\Pi_{i,t}$	Bank i's profit on its own CDS book
$K_{i,t}$	Bank i's exposure-weighted counterparty profit
$\sum_{j \neq i} \Pi_{j,t}$	Sum of other banks' CDS trading profits
$\sum_{j \neq i} NP^{\text{Bank}}_{i,j,t}$	Sum of other banks' net CDS positions
controls	VIX, ΔVIX, $VFTSE$, $\Delta VFTSE$, MSCI, S&P 500, FTSE 100 returns, average (Δ) CDS spread

▸ variables

Impact of counterparty profits on CDS spreads

	(1)	(3)	(5)	(7)
Own profits	-0.381	-0.225	0.000	-0.955
	[1.011]	[0.465]	[0.475]	[0.718]
Counterparty profits	**-1.370*** **	**-0.433** **	**-0.450** **	**-0.865*** **
	[0.416]	**[0.192]**	**[0.198]**	**[0.294]**
Total exposure			-0.003	-0.003
			[0.002]	[0.003]
All other bank profits			0.241**	-0.683***
			[0.010]	[0.137]
Controls:				
S&P500, FTSE100	-	returns	returns	returns
VIX, VFTSE	-	changes	changes	levels
Average CDS spread	-	changes	changes	levels
Adjusted R2	0.072	0.338	0.339	0.219

Table: Panel regression with bank and year fixed effects. Robust standard errors in brackets. Coefficient and standard errors on counteparty profits multiplied by 1,000. A one-standard deviation counterparty loss raises a bank's own CDS spread by 26-83 bps (An increase from 100 bps to 100.26-100.83 bps).

Common risks versus transmission

- **Alternative:** bank A and its counterparty B both have common exposure to shock not shared by rest of market. ("common exposure" hypothesis)
- Difficult to address without more data!
- **Common exposure:** A and B should experience losses (and therefore credit decline) from common shock regardless of whether A buys from or sells to B.
- **Transmission:** A should only experience credit decline when A buys from B, not when A sells.
- **Test:** run the regression with $K^B_{i,t}$ and $K^S_{i,t}$ – only the coefficient on $K^B_{i,t}$ should be significant.

Impact of net bought vs net sold CP P/L on CDS spreads

	(1)	(3)	(5)	(7)
Own profits	-0.637	-0.265	-0.0640	-0.990
	[1.191]	[0.529]	[0.518]	[0.823]
Cpty profits (net bought)	**-1.810****	**-0.500***	**-0.598***	**-0.945***
	[0.669]	**[0.284]**	**[0.305]**	**[0.484]**
Cpty profits (net sold)	**0.781**	**0.343**	**0.260**	**0.763**
	[1.210]	**[0.500]**	**[0.513]**	**[0.869]**
Total exposure (net bought)			-0.000	0.000
			[0.003]	[0.004]
Total exposure (net sold)			0.004	0.006*
			[0.004]	[0.003]
All other bank profits			0.263**	-0.671***
			[0.110]	[0.144]
Controls:				
S&P500, FTSE100	-	returns	returns	returns
VIX, VFTSE	-	changes	changes	levels
Average CDS spread	-	changes	changes	levels
Adjusted R2	0.073	0.338	0.339	0.219

Table: Panel regression with bank and year fixed effects. Robust standard errors in brackets. Coefficient and standard errors on counteparty profits multiplied by 1,000.

Further results

- The impact of central clearing
  - A bank that elects not to centrally clear their trades (in clearing-eligible contracts) reveals a lack of concern for counterparty risk $\rightarrow$ we find that the effect of counterparty losses is smaller for eligible contracts.
- Excluding top 10 banks
  - Small banks are expected to rely more on the CDS market for hedging implying that they should be more affected by the counterparty risk channel $\rightarrow$ our results confirm that.
- Dummy variable for banks with a single counterparty
  - If a bank has a single counterparty and the counterparty is hit by a shock, it is more likely the market reacts stronger, as it is more likely aware of this relationship $\rightarrow$ we find this in the data.
- Equity returns in place of CDS returns
  - By Modigliani-Miller, the same results should hold for equity returns $\rightarrow$ our estimates have the right sign, but tend to be less statistically significant.

Discussion and ongoing work

- We find statistical evidence for contagion.
- Effect on dealer credit risk from CDS losses likely extremely small $\rightarrow$ we are building a Merton-type network model to try to understand economic magnitude of gamma.
- How do equity and CDS market players know about CDS positions and losses? (Might know of large exposure but identity of counterparties?)
- Exogenous shocks to CCR should deliver comparable effect. We have data on FCA bank fines and their announcement dates.

Variables: net positions

- Gross amount of CDS protection bought by bank i from bank j on entity k on day t: $P_{i,j,k,t}$,
- Net position of bank i in reference entity k on day t:

$$NP^{\text{Ent}}_{i,k,t} = \sum_{j:j\neq i} NP_{i,j,k,t}, \quad NP_{i,j,k,t} = (P_{i,j,k,t} - P_{j,i,k,t}).$$

- Net exposure of bank i to bank j at t

$$NP^{\text{Bank}}_{i,j,t} = \sum_{k} NP_{i,j,k,t}, \quad NP_{i,j,k,t} = (P_{i,j,k,t} - P_{j,i,k,t}).$$

- We can decompose as $NP^{\text{Bank}}_{i,j,t} = NP^{\text{Bank,B}}_{i,j,t} - NP^{\text{Bank,S}}_{i,j,t}$, where

$$NP^{\text{Bank,B}}_{i,j,t} = \max\{NP^{\text{Bank}}_{i,j,t}, 0\}, \quad NP^{\text{Bank,S}}_{i,j,t} = -\min\{NP^{\text{Bank}}_{i,j,t}, 0\}$$

regression

Variables: profits and losses (P/L)

- Given the date t CDS spread $CDS_{k,t}$ of reference entity k, we approximate the daily CDS return $R_{k,t}$ of entity k by

$$R_{k,t} = \ln CDS_{k,t} - \ln CDS_{k,t-1}.$$

(Accurate at daily frequency: Hilscher et al., 2015).

- Bank i's profit or loss on its CDS exposure to entity k between date t and $t+1$ is therefore

$$\Pi_{i,k,t}^{\text{Ent}} = NP_{i,k,t}^{\text{Ent}} R_{k,t+1},$$

and its profit or loss an all of its open CDS position is

$$\Pi_{i,t} = \sum_k \Pi_{i,k,t}^{\text{Ent}}.$$

regression

Variables: exposure-weigted counterparty P/L

- Bank's i time t exposure-weighted counterparty profit or loss:

$$K_{i,t} = \sum_{i \neq j} NP_{i,j,t}^{\text{Bank}} \Pi_{j,t}.$$

- Bank i's counterparty profits for counterparties with whom it has a net long position:

$$K_{i,t}^{B} = \sum_{i \neq j} NP_{i,j,t}^{\text{Bank,B}} \Pi_{j,t}.$$

- Bank i's counterparty profits for counterparties with whom it has a net short position:

$$K_{i,t}^{S} = \sum_{i \neq j} NP_{i,j,t}^{\text{Bank,S}} \Pi_{j,t}.$$

regression